US011309340B2

(12) **United States Patent**
Zhao

(10) **Patent No.: US 11,309,340 B2**
(45) **Date of Patent: Apr. 19, 2022**

(54) **DISPLAY PANEL**

(71) Applicant: **Wuhan China Star Optoelectronics Semiconductor Display Technology Co., Ltd.**, Wuhan (CN)

(72) Inventor: **Jinrong Zhao**, Wuhan (CN)

(73) Assignee: **Wuhan China Star Optoelectronics Saniconductor Display Technology Co., Ltd.**, Wuhan (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 278 days.

(21) Appl. No.: **16/619,237**

(22) PCT Filed: **Oct. 24, 2019**

(86) PCT No.: **PCT/CN2019/113031**
§ 371 (c)(1),
(2) Date: **Dec. 4, 2019**

(87) PCT Pub. No.: **WO2021/027066**
PCT Pub. Date: **Feb. 18, 2021**

(65) **Prior Publication Data**

US 2021/0358974 A1 Nov. 18, 2021

(30) **Foreign Application Priority Data**

Aug. 13, 2019 (CN) 201910744064.5

(51) **Int. Cl.**
H01L 27/12 (2006.01)
H01L 27/32 (2006.01)
H01L 51/56 (2006.01)

(52) **U.S. Cl.**
CPC ***H01L 27/1248*** (2013.01); ***H01L 27/1244*** (2013.01)

(58) **Field of Classification Search**
CPC ... H01L 27/12; H01L 27/124; H01L 27/1218; H01L 27/1244; H01L 27/1248; H01L 27/1259; H01L 27/32; H01L 27/327; H01L 27/3258; H01L 27/3276; H01L 51/003; H01L 51/0097; H01L 51/56; G09F 9/301
USPC 257/72
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2017/0288005 A1* 10/2017 Kawata H01L 27/12
2018/0092166 A1* 3/2018 Kim H01L 51/0097
2018/0366586 A1 12/2018 Son et al.
2021/0184139 A1 6/2021 Zhang et al.

FOREIGN PATENT DOCUMENTS

CN 109148514 A 1/2019
CN 109755256 A 5/2019
CN 109887956 A 6/2019

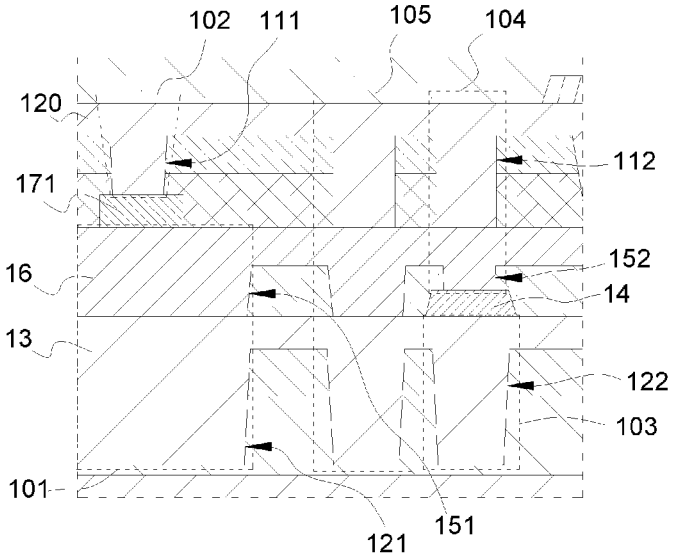
* cited by examiner

Primary Examiner — Fazli Erdem

(57) **ABSTRACT**

A display panel includes a substrate, a first gate-electrode metal layer, a first organism, and a second organism. The first organism is disposed on one surface of the first gate-electrode metal layer near the substrate in order that a bending stress is released. The second organism is disposed on one surface of the first gate-electrode metal layer away from the substrate in order that the bending stress is released. Organisms are disposed above a metal trace and below the metal trace, so that a stress which occurs in inorganic layers can be released through the organisms when the display panel is being bent.

17 Claims, 5 Drawing Sheets



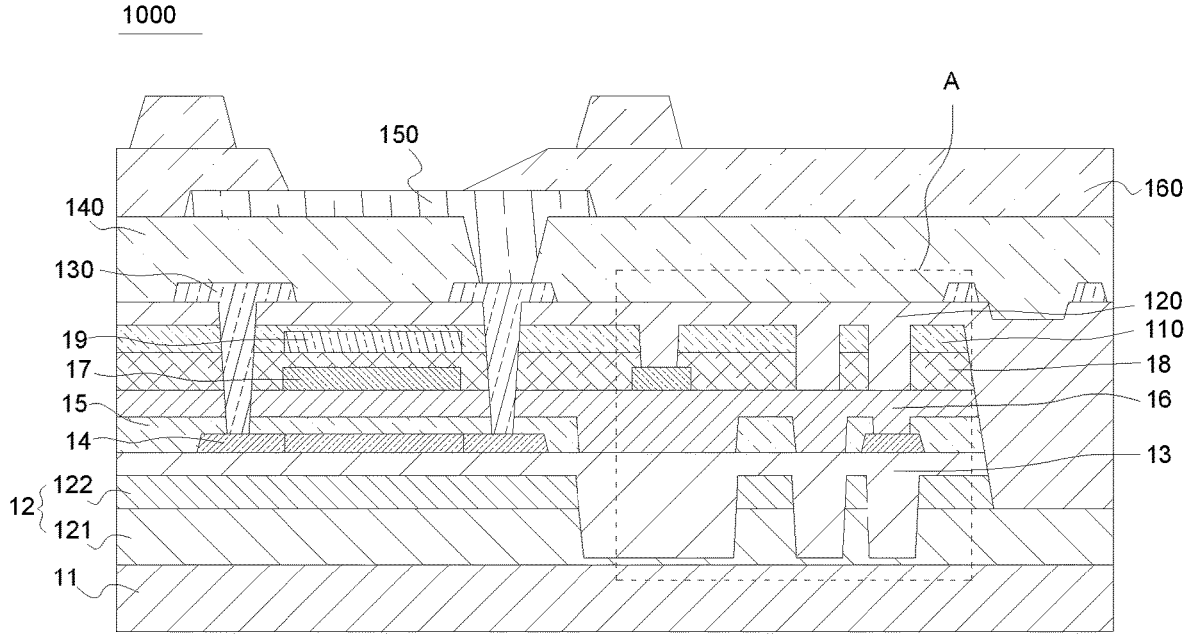

1000
A
150
160
140
130
120
110
19
18
17
16
15
14
13
12
122
121
11

FIG. 1

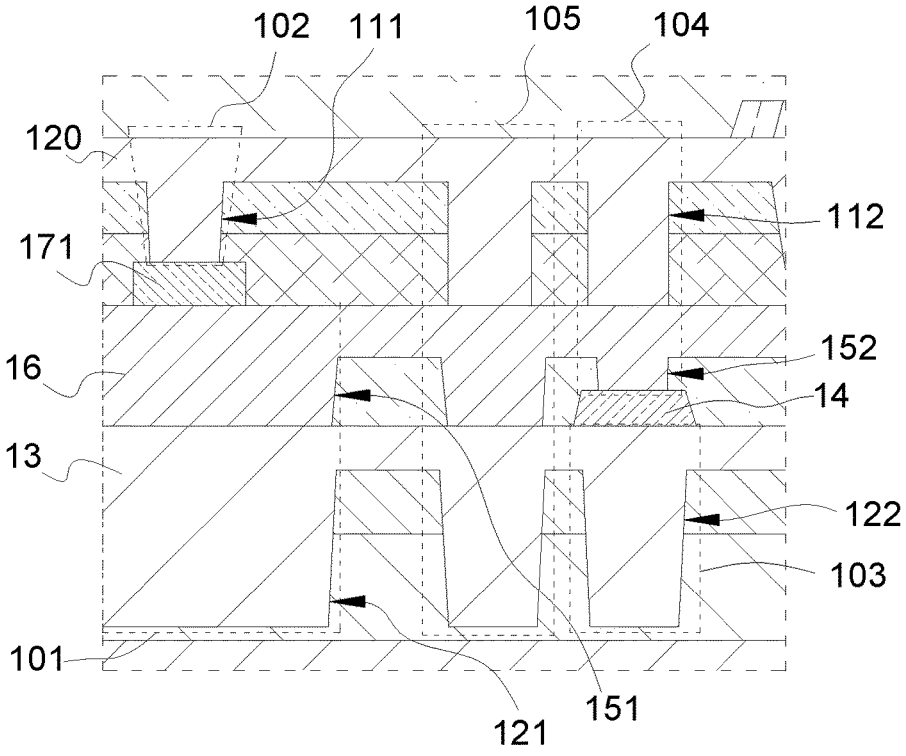

102
111
105
104
120
112
171
152
16
14
13
122
103
101
151
121

FIG. 2

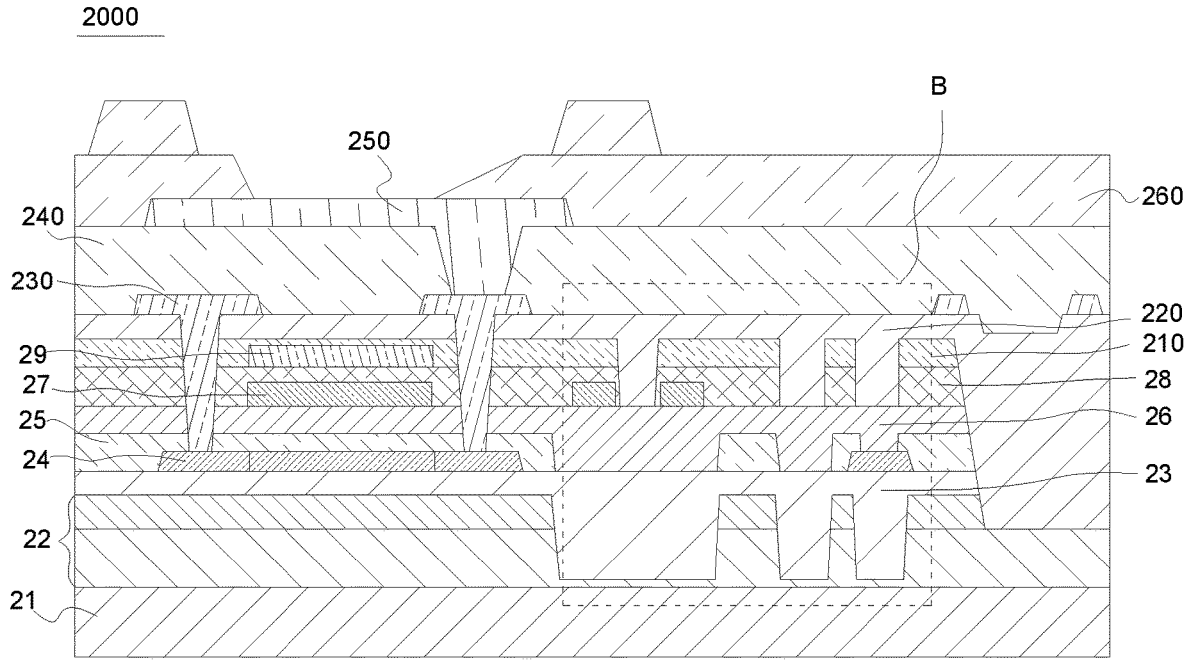


FIG. 3

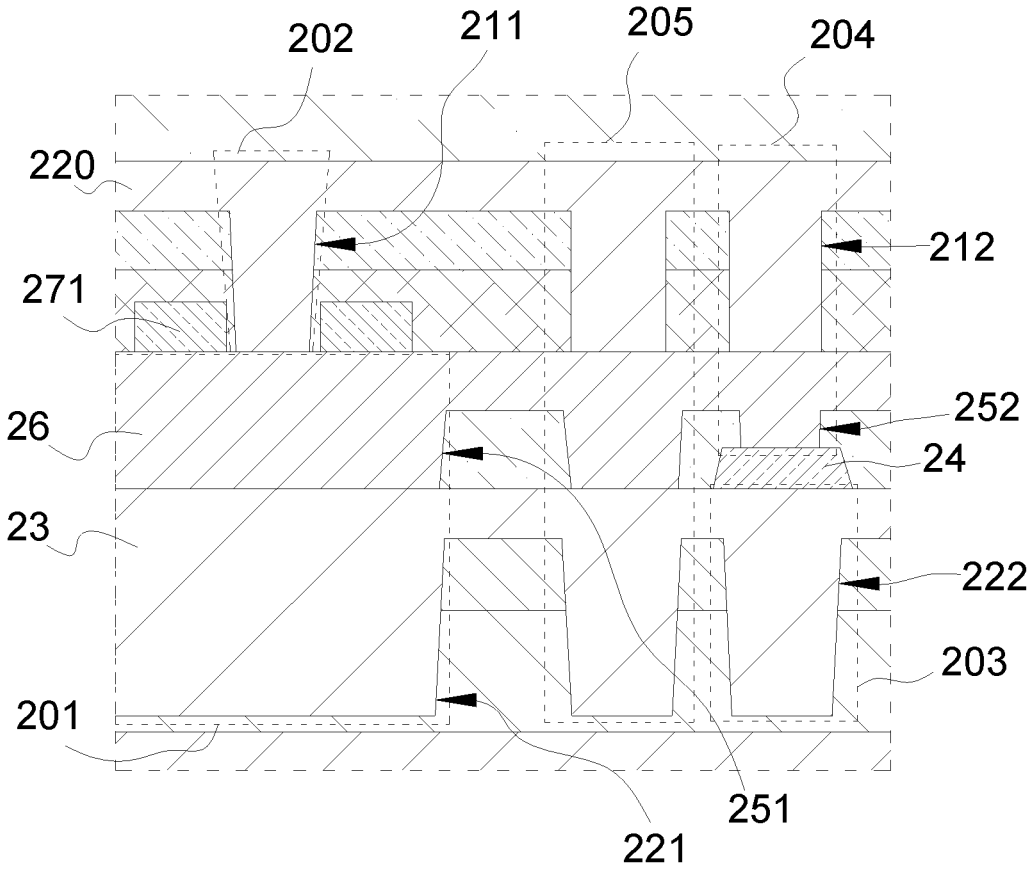

202
211
205
204
220
212
271
252
26
24
23
222
203
201
251
221

FIG. 4

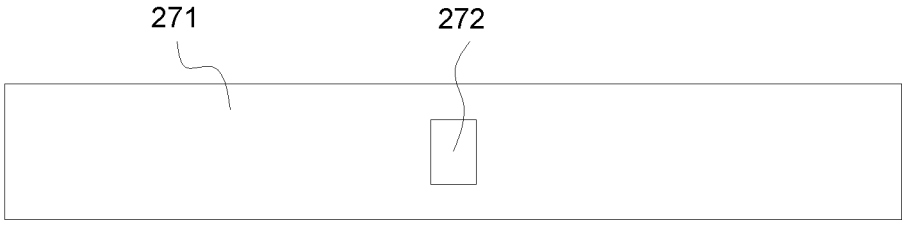

271
272

FIG. 5

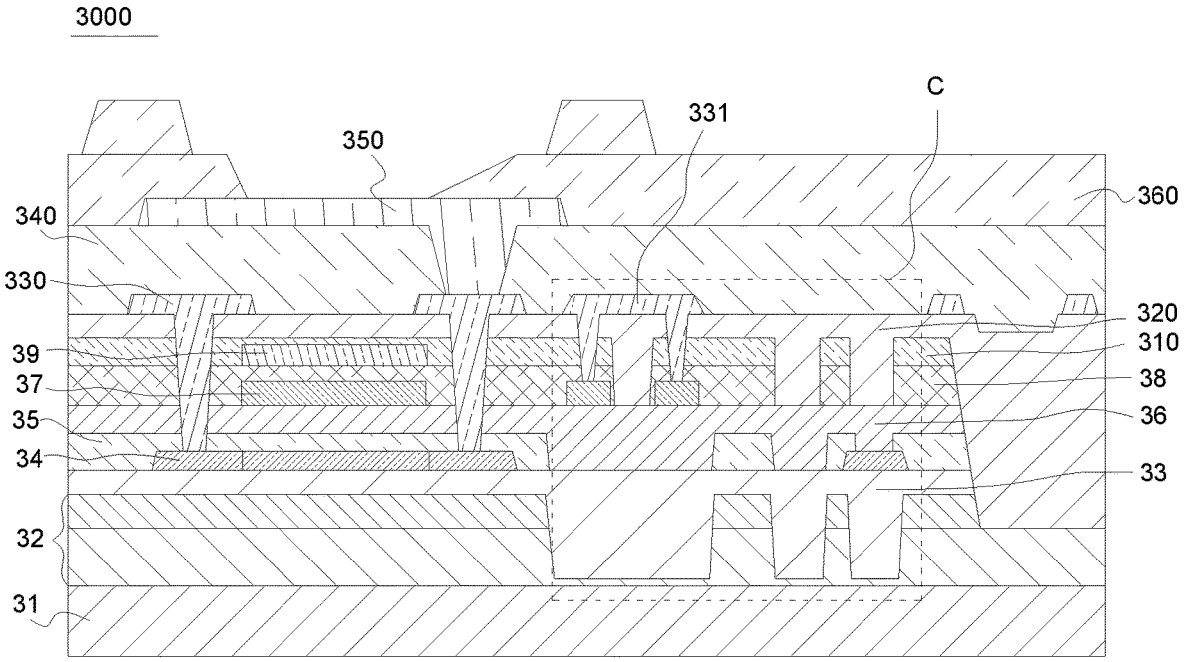


FIG. 6

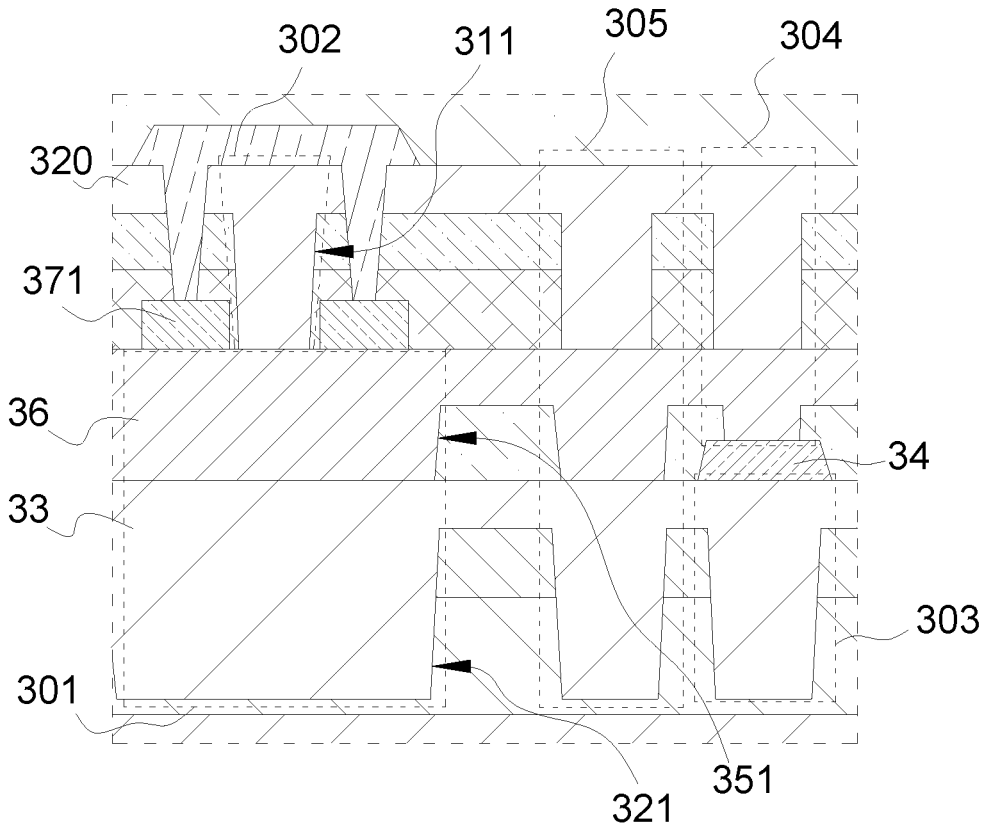

302
311
305
304
320
371
36
34
33
303
301
351
321

FIG. 7

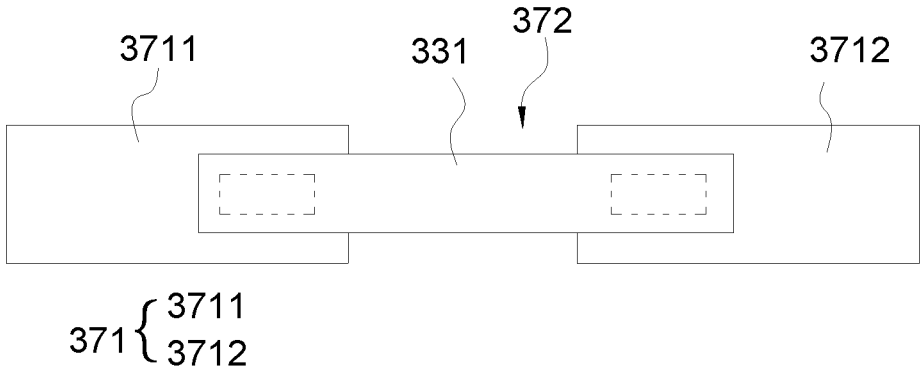

3711
331
372
3712
371
3711
3712

FIG. 8

DISPLAY PANEL

BACKGROUND OF DISCLOSURE

1. Field of Disclosure

The present disclosure relates to the field of display technology, and more particularly, to a display panel.

2. Description of Related Art

In conventional flexible display panels, inorganic layers such as a buffer layer, a blocking layer, and an insulating layer are made of brittle materials. During the course of being bent continuously, the inorganic layers are prone to break and further break worse, thereby causing a source-and-drain electrode metal layer, a gate-electrode metal layer, or an active layer to break. Abnormal performance of thin-film transistors or a failed flexible display screen may be caused.

SUMMARY

An embodiment of the present disclosure provides a display panel to solve a technical problem that a gate-electrode metal layer and/or an active layer break while a conventional display panel is bent or folded.

An embodiment of the present disclosure provides a display panel, including:

a substrate;

a first gate-electrode metal layer disposed on the substrate;

a first organism disposed on one surface of the first gate-electrode metal layer near the substrate in order that a bending stress is released; and

a second organism disposed on one surface of the first gate-electrode metal layer away from the substrate in order that the bending stress is released.

In the display panel of the present disclosure, the first gate-electrode metal layer includes a metal trace, the metal trace includes a first surface and a second surface disposed back to back, and the first surface is located at one side of the metal trace near the substrate.

The first organism is disposed on one side of the first surface, and the second organism is disposed on one side of the second surface.

In the display panel of the present disclosure, the first organism is in contact with the first surface, and the second organism is in contact with the second surface.

In the display panel of the present disclosure, a hole is defined in the metal trace, and the second organism passes through the hole to be in contact with the first organism.

In the display panel of the present disclosure, an opening is disposed in the metal trace, the opening splits the metal trace into two sections, and the second organism passes through the opening to be in contact with the first organism.

The display panel of the present disclosure further includes:

an underlay structure layer disposed on the substrate, wherein a first hollow portion is disposed in the underlay structure layer;

a first organic layer disposed on the underlay structure layer, wherein the first hollow portion is filled with the first organic layer;

an active layer disposed on the first organic layer;

a first insulating layer disposed on the active layer, wherein a second hollow portion is disposed in the first insulating layer and arranged corresponding to the first hollow portion, and the first organic layer is exposed from the second hollow portion;

a second organic layer disposed on the first insulating layer, wherein the second hollow portion is filled with the second organic layer;

the first gate-electrode metal layer is disposed on the second organic layer, and the metal trace is disposed above the second hollow portion correspondingly;

a second insulating layer disposed on the first gate-electrode metal layer;

a second gate-electrode metal layer disposed on the second insulating layer;

a third insulating layer disposed on the second gate-electrode metal layer, wherein a third hollow portion is disposed in the third insulating layer and passes through the second insulating layer, and the metal trace is exposed from the third hollow portion;

a third organic layer disposed on the third insulating layer, wherein the third hollow portion is filled with the third organic layer; and

a source-and-drain electrode metal layer disposed on the third organic layer;

wherein the first organism is formed from the first organic layer which fills the first hollow portion, and the second organic layer which fills the second hollow portion; and wherein the second organism is formed from the third organic layer which fills the third hollow portion.

The display panel of the present disclosure further includes:

an underlay structure layer disposed on the substrate, wherein a first hollow portion is disposed in the underlay structure layer;

a first organic layer disposed on the underlay structure layer, wherein the first hollow portion is filled with the first organic layer;

an active layer disposed on the first organic layer;

a first insulating layer disposed on the active layer, wherein a second hollow portion is disposed in the first insulating layer and arranged corresponding to the first hollow portion, and the first organic layer is exposed from the second hollow portion;

a second organic layer disposed on the first insulating layer, wherein the second hollow portion is filled with the second organic layer;

the first gate-electrode metal layer is disposed on the second organic layer, and the metal trace is disposed above the second hollow portion correspondingly;

a second insulating layer disposed on the first gate-electrode metal layer;

a second gate-electrode metal layer disposed on the second insulating layer;

a third insulating layer disposed on the second gate-electrode metal layer, wherein a third hollow portion is disposed in the third insulating layer and passes through the metal trace, and the second organic layer is exposed from the second hollow portion;

a third organic layer disposed on the third insulating layer, wherein the third hollow portion is filled with the third organic layer; and

a source-and-drain electrode metal layer disposed on the third organic layer;

wherein the first organism is formed from the first organic layer which fills the first hollow portion, and the second organic layer which fills the second hollow portion; and wherein the second organism is formed from the third organic layer which fills the third hollow portion.

The display panel of the present disclosure further includes:

an underlay structure layer disposed on the substrate, wherein a first hollow portion is disposed in the underlay structure layer;

a first organic layer disposed on the underlay structure layer, wherein the first hollow portion is filled with the first organic layer;

an active layer disposed on the first organic layer;

a first insulating layer disposed on the active layer, wherein a second hollow portion is disposed in the first insulating layer and arranged corresponding to the first hollow portion, and the first organic layer is exposed from the second hollow portion;

a second organic layer disposed on the first insulating layer, wherein the second hollow portion is filled with the second organic layer;

the first gate-electrode metal layer is disposed on the second organic layer, and the metal trace is disposed above the second hollow portion correspondingly;

a second insulating layer disposed on the first gate-electrode metal layer;

a second gate-electrode metal layer disposed on the second insulating layer;

a third insulating layer disposed on the second gate-electrode metal layer, wherein a third hollow portion is disposed in the third insulating layer and passes through and splits the metal trace, and the second organic layer is exposed from the third hollow portion;

a third organic layer disposed on the third insulating layer, wherein the third hollow portion is filled with the third organic layer; and

a source-and-drain electrode metal layer disposed on the third organic layer and including a passing bridge, wherein the split metal traces are electrically connected together through the passing bridge;

wherein the first organism is formed from the first organic layer which fills the first hollow portion, and the second organic layer which fills the second hollow portion; and wherein the second organism is formed from the third organic layer which fills the third hollow portion.

The display panel of the present disclosure further includes: a third organism disposed on one surface of the active layer near the substrate; and a fourth organism disposed on one surface of the active layer away from the substrate.

In the display panel of the present disclosure, a fourth hollow portion is disposed in the underlay structure layer, the fourth hollow portion is filled with the first organic layer, a part of the active layer is disposed above the fourth hollow portion correspondingly;

wherein a fifth hollow portion is disposed in the first insulating layer and arranged corresponding to a part of the active layer, a part of the active layer is exposed from the fifth hollow portion, and the fifth hollow portion is filled with the second organic layer;

wherein a sixth hollow portion is disposed in the third insulating layer and passes through the second insulating layer, the second organic layer is exposed from the sixth hollow portion, the sixth hollow portion is disposed corresponding to the fifth hollow portion, and the sixth hollow portion is filled with the third organic layer;

wherein the third organism is formed from the first organic layer which fills the fourth hollow portion; and wherein the fourth organism is formed from the second organic layer which fills the fifth hollow portion, and the third organic layer which fills the sixth hollow portion.

The display panel of the present disclosure further includes a fifth organism disposed on one or two sides of the active layer and/or the metal trace.

In the display panel of the present disclosure, the first hollow portion, the second hollow portion, the third hollow portion, the fourth hollow portion, the fifth hollow portion, and the sixth hollow portion have shapes of hole or groove.

In the display panel of the present disclosure, the source-and-drain electrode metal layer includes the passing bridge, the metal trace includes a first section and a second section, and the opening disconnects the first section from the second section;

wherein the first section is electrically connected to one end of the passing bridge through a through-hole, and the second section is electrically connected to the other end of the passing bridge through another through-hole.

Compared with a display panel in conventional technologies, in the display panel of the present disclosure, organic materials are disposed above a metal trace and below the metal trace. Because of the flexibility of the organic materials, a stress which occurs in inorganic layers can be effectively released through the organic materials when the display panel is being bent, further preventing the metal trace from breaking. Thus, a technical problem that a gate-electrode metal layer and/or an active layer break while a conventional display panel is bent or folded can be solved.

BRIEF DESCRIPTION OF DRAWINGS

In order to more clearly illustrate the embodiments of the present disclosure or technical solutions in conventional technologies, the accompanying drawings required for describing the embodiments will be briefly introduced below. The following drawings are merely a part of the embodiments of the present disclosure, and a person having ordinary skill in this field can obtain other drawings according to these drawings under the premise of not paying creative works.

FIG. **1** is a schematic structural diagram of a display panel according to a first embodiment of the present disclosure.

FIG. **2** is an enlarged view of a part A shown in FIG. **1**.

FIG. **3** is a schematic structural diagram of a display panel according to a second embodiment of the present disclosure.

FIG. **4** is an enlarged view of a part B shown in FIG. **3**.

FIG. **5** is a vertical view of a metal trace of the display panel of the second embodiment of the present disclosure.

FIG. **6** is a schematic structural diagram of a display panel according to a third embodiment of the present disclosure.

FIG. **7** is an enlarged view of a part C shown in FIG. **6**.

FIG. **8** is a vertical view of a metal trace and a passing bridge connected with each other in the display panel of the third embodiment of the present disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS

Please refer to the appending drawings, the same components are indicated by the same reference numbers. The following descriptions are based on the exemplary embodiment of the present disclosure and should not be taken to limit the present disclosure and other embodiments not described herein.

Please refer to FIG. **1**, which is a schematic structural diagram of a display panel according to a first embodiment of the present disclosure. An embodiment of the present disclosure provides a display panel **1000**, including a substrate **11**, an underlay structure layer **12**, a first organic layer **13**, an active layer **14**, a first insulating layer **15**, a second

organic layer **16**, a first gate-electrode metal layer **17**, a second insulating layer **18**, a second gate-electrode metal layer **19**, a third insulating layer **110**, a third organic layer **120**, a source-and-drain electrode metal layer **130**, a planarization layer **140**, an anode layer **150**, and a pixel definition layer **160**.

The underlay structure layer **12** is disposed on the substrate **11**. Specifically, the underlay structure layer **12** includes a blocking layer **121** disposed on the substrate **11**, and a buffer layer **122** disposed on the blocking layer **121**.

The first organic layer **13** is disposed on the underlay structure layer **12**. The active layer **14** is disposed on the first organic layer **13**. The first insulating layer **15** is disposed on the active layer **14**. The second organic layer **16** is disposed on the first insulating layer **15**. The first gate-electrode metal layer **17** is disposed on the second organic layer **16**. The second insulating layer **18** is disposed on the first gate-electrode metal layer **17**. The second gate-electrode metal layer **19** is disposed on the second insulating layer **18**. The third insulating layer **110** is disposed on the second gate-electrode metal layer **19**. The third organic layer **120** is disposed on the third insulating layer **110**. The source-and-drain electrode metal layer **130** is disposed on the third organic layer **120**.

The planarization layer **140** is disposed on the source-and-drain electrode metal layer **130**. The anode layer **150** is disposed on the planarization layer **140**. The pixel definition layer **160** is disposed on the anode layer **150**.

The underlay structure layer **12**, the first insulating layer **15**, the second insulating layer **18**, and the third insulating layer **110** are all inorganic layers. Optionally, a material of the blocking layer **121** can be SiO2. A material of the buffer layer **122** can be SiNx/SiO2. Materials of the first insulating layer **15**, the second insulating layer **18**, and the third insulating layer **110** can be all SiO2/SiNx.

The first organic layer **13**, the second organic layer **16**, and the third insulating layer **110** can be made of organic photoresist materials.

The display panel **1000** further includes a first organism **101**, a second organism **102**, a third organism **103**, a fourth organism **104**, and a fifth organism **105**, all of which are used for releasing a bending stress.

The first organism **101** is disposed on one surface of the first gate-electrode metal layer **17** near the substrate **11** in order that a bending stress is released. The second organism **102** is disposed on one surface of the first gate-electrode metal layer **17** away from the substrate **11** in order that the bending stress is released.

In the first embodiment, the first organism **101** and the second organism **102** are respectively disposed on two end faces of the first gate-electrode metal layer **17**, i.e., a first end face and a second end face. Since organisms have superior flexibility, a bending stress occurs in the first gate-electrode metal layer **17** when the first gate-electrode metal layer **17** is bent. Then, the bending stress is released through the first organism **101** and the second organism **102**, and the first gate-electrode metal layer **17** is further protected.

Specifically, the first gate-electrode metal layer **17** includes a metal trace **171** and a first gate electrode **172**. The first gate electrode **172** is used to form a thin-film transistor. The metal trace **171** includes a first surface and a second surface disposed back to back. The first surface is located at one side of the metal trace **171** near the substrate **11**, and the second surface is located at one side of the metal trace **171** away from the substrate **11**.

The first organism **101** is disposed on one side of the first surface, and the second organism **102** is disposed on one side of the second surface. In such arrangement, the first organism **101** and the second organism **102** are used for releasing a bending stress in the metal trace **171** when the metal trace **171** is bent.

In the first embodiment, the first organism **101** is in contact with the first surface of the metal trace **171**, and the second organism **102** is in contact with the second surface of the metal trace **171**.

Optionally, the first organism **101** covers at least one part of the first surface of the metal trace **171**, and the second organism **102** completely covers the second surface of the metal trace **171**.

Further, the metal trace **171** includes a first part and a second part. A width of the first part is greater than that of the second part. The first organism **101** is disposed on the first part. Since the greater the width of the metal trace **171**, the greater the received bending stress, the bending stress is required to be released.

In the first embodiment, as shown in FIG. **2**, based on the above structure, a first hollow portion **121** is disposed in the underlay structure layer **12**. The first organic layer **13** is disposed on the underlay structure layer **12** and fills the first hollow portion **121**.

A second hollow portion **151** is disposed in the first insulating layer **15** and arranged corresponding to the first hollow portion **121**, and the first organic layer **13** is exposed from the second hollow portion **151**. The second organic layer **16** is disposed on the first insulating layer **15** and fills the second hollow portion **151**.

The metal trace **171** is disposed above the second hollow portion **151** correspondingly.

A third hollow portion **111** is disposed in the third insulating layer **110** and passes through the second insulating layer **18**, and the metal trace **171** is exposed from the third hollow portion **111**. The third organic layer **120** is disposed on the third insulating layer **110** and fills the third hollow portion **111**.

The first organism **101** is formed from the first organic layer **13** which fills the first hollow portion **121**, and the second organic layer **16** which fills the second hollow portion **151**. The second organism **102** is formed from the third organic layer **120** which fills the third hollow portion **111**.

Optionally, the first hollow portion **121**, the second hollow portion **151**, and the third hollow portion **111** have shapes of hole or groove. The first hollow portion **121**, the second hollow portion **151**, and the third hollow portion **111** can be prepared by a photolithography process or a dry-etching process.

When the first hollow portion **121**, the second hollow portion **151**, and the third hollow portion **111** are of hole structures, they are disposed on the same axis and on a vertical plane. On the horizontal, the first hollow portions **121** are disposed apart from each other, the second hollow portions **151** are disposed apart from each other, and the third hollow portions **111** are disposed apart from each other.

Further, the third hollow portion **111** is arranged along an extending direction of the metal trace **171**. A distance between the third hollow portions **111** gradually increases from a middle position to two side positions, causing a distance between the second organisms **102** to gradually increase from a middle position to two side positions. Such arrangement can improve the ability of releasing a bending stress.

In addition, a third organism **103** is disposed on one surface of the active layer **14** near the substrate **11**, and a fourth organism **104** is disposed on one surface of the active

layer **14** away from the substrate **11**. In the first embodiment, the third organism **103** and the fourth organism **104** are disposed on a top surface and a bottom surface of a part of the active layer **14** respectively.

Specifically, a fourth hollow portion **122** is disposed in the underlay structure layer **12**. The fourth hollow portion **122** is filled with the first organic layer **13**. A part of the active layer **14** is disposed above the fourth hollow portion **122** correspondingly.

A fifth hollow portion **152** is disposed in the first insulating layer **15** and arranged corresponding to a part of the active layer **14**, a part of the active layer **14** is exposed from the fifth hollow portion **152**, and the fifth hollow portion **152** is filled with the second organic layer **16**.

A sixth hollow portion **112** is disposed in the third insulating layer **110** and passes through the second insulating layer **18**, the second organic layer **16** is exposed from the sixth hollow portion **112**, the sixth hollow portion **112** is disposed corresponding to the fifth hollow portion **152**, and the sixth hollow portion **112** is filled with the third organic layer **120**.

The third organism **103** is formed from the first organic layer **13** which fills the fourth hollow portion **122**. The fourth organism **104** is formed from the second organic layer **16** which fills the fifth hollow portion **152**, and the third organic layer **120** which fills the sixth hollow portion **112**.

In such arrangement, the third organism **103** and the fourth organism **104** are used for releasing a bending stress in the active layer **14** when the active layer **14** is bent.

Optionally, the fourth hollow portion **122**, the fifth hollow portion **152**, and the sixth hollow portion **112** have shapes of hole or groove.

When the fourth hollow portion **122**, the fifth hollow portion **152**, and the sixth hollow portion **112** are of hole structures, they are disposed on the same axis and on a vertical plane. On the horizontal, the fourth hollow portion **122** are disposed apart from each other, the fifth hollow portion **152** are disposed apart from each other, and the sixth hollow portion **112** are disposed apart from each other.

Further, the fourth hollow portion **122** is arranged along an extending direction of the active layer **14**. A distance between the fourth hollow portions **122** gradually increases from a middle position to two side positions, causing a distance between the third organisms **103** to gradually increase from a middle position to two side positions. Such arrangement can improve the ability of releasing a bending stress.

In addition, in the first embodiment, a fifth organism **105** is disposed on one or two sides of the active layer **14** and/or the metal trace **171**.

Specifically, the fifth organism **105** is disposed between the active layer **14** and the metal trace **171**. A hollow portion is disposed in the position where the fifth organism **105** is located in order that at least one of the first organic layer **13**, the second organic layer **16**, and the third organic layer **120** fills the hollow portion to form the fifth organism **105**.

The fifth organism **105** is formed through digging the hollow portion and then through filling the hollow portion with an organic layer. Such arrangement increases an area of the hollow portion of the display panel and fills with more of the fifth organism **105**, which can release a bending stress of an inorganic layer located on two sides of the fifth organism **105**. Thus, the anti-bendability of the display panel is improved.

It needs to be stated that the first embodiment shown in FIG. **1** only shows a display region of the display panel **1000** but cannot restrict the claimed scope of the present disclosure. For example, the metal trace **171** can also be introduced into a non-display region, and thus an organism can be disposed in the non-display region.

Please refer to FIGS. **3-5**, wherein FIG. **3** is a schematic structural diagram of a display panel according to a second embodiment of the present disclosure, FIG. **4** is an enlarged view of a part B shown in FIG. **3**, and FIG. **5** is a vertical view of a metal trace of the display panel of the second embodiment of the present disclosure.

The difference that exists between the display panel **2000** of the second embodiment of the present disclosure and the display panel **1000** of the first embodiment is that a hole **272** is defined in the metal trace **271** and that the second organism **202** passes through the hole **272** to be in contact with the first organism **201**.

In the second embodiment, a display panel **2000** includes a substrate **21**, an underlay structure layer **22**, a first organic layer **23**, an active layer **24**, a first insulating layer **25**, a second organic layer **26**, a first gate-electrode metal layer **27**, a second insulating layer **28**, a second gate-electrode metal layer **29**, a third insulating layer **210**, a third organic layer **220**, a source-and-drain electrode metal layer **230**, a planarization layer **240**, an anode layer **250**, and a pixel definition layer **260**.

The display panel **2000** includes a first organism **201**, a second organism **202**, a third organism **203**, a fourth organism **204**, and a fifth organism **205**.

Specifically, the underlay structure layer **22** is disposed on the substrate **21**. A first hollow portion **221** is disposed in the underlay structure layer **22**. The first organic layer **23** is disposed on the underlay structure layer **22**, and the first hollow portion **221** is filled with the first organic layer **23**. The active layer **24** is disposed on the first organic layer **23**.

The first insulating layer **25** is disposed on the active layer **24**. A second hollow portion **251** is disposed in the first insulating layer **25** and arranged corresponding to the first hollow portion **221**. The first organic layer **23** is exposed from the second hollow portion **251**. The second organic layer **26** is disposed on the first insulating layer **25**, and the second hollow portion **251** is filled with the second organic layer **26**.

The first gate-electrode metal layer **27** is disposed on the second organic layer **26**, and the metal trace **271** is disposed above the second hollow portion **251** correspondingly. The second insulating layer **28** is disposed on the first gate-electrode metal layer **27**. The second gate-electrode metal layer **29** is disposed on the second insulating layer **28**.

The third insulating layer **210** is disposed on the second gate-electrode metal layer **29**. A third hollow portion **211** is disposed in the third insulating layer **210** and passes through the metal trace **271**. The second organic layer **26** is exposed from the third hollow portion **211**.

The third organic layer **220** is disposed on the third insulating layer **210**, and the third hollow portion **211** is filled with the third organic layer **220**.

The source-and-drain electrode metal layer **230** is disposed on the third organic layer **220**.

The first organism **201** is formed from the first organic layer **23** which fills the first hollow portion **221**, and the second organic layer **26** which fills the second hollow portion **251**. The second organism **202** is formed from the third organic layer **220** which fills the third hollow portion **211**.

The second organism **202** extends into the hole **272** to be in contact with the first organism **201**.

The difference that exists between the second embodiment and the first embodiment is that the structures of the

metal trace **271** and the second organism **202** are different. Specifically, other structures can be referred in the description of the first embodiment.

Please refer to FIGS. **6-8**, wherein FIG. **6** is a schematic structural diagram of a display panel according to a third embodiment of the present disclosure, FIG. **7** is an enlarged view of a part C shown in FIG. **6**, and FIG. **8** is a vertical view of a metal trace and a passing bridge connected with each other in the display panel of the third embodiment of the present disclosure.

The difference that exists between the display panel **3000** of the third embodiment of the present disclosure and the display panel **1000** of the first embodiment is that an opening **372** is disposed in the metal trace **371**. The opening **372** splits the metal trace **371** into two sections. The second organism **302** passes through the opening **372** to be in contact with the first organism **301**. Two split metal traces **371** are electrically connected together through a passing bridge **331** of a source-and-drain electrode metal layer **330**.

Specifically, in the third embodiment of the present disclosure, a display panel **3000** includes a substrate **31**, an underlay structure layer **32**, a first organic layer **33**, an active layer **34**, a first insulating layer **35**, a second organic layer **36**, a first gate-electrode metal layer **37**, a second insulating layer **38**, a second gate-electrode metal layer **39**, a third insulating layer **310**, a third organic layer **320**, a source-and-drain electrode metal layer **330**, a planarization layer **340**, an anode layer **350**, and a pixel definition layer **360**.

The display panel **3000** includes a first organism **301**, a second organism **302**, a third organism **303**, a fourth organism **304**, and a fifth organism **305**.

The underlay structure layer **32** is disposed on the substrate **31**. A first hollow portion **321** is disposed in the underlay structure layer **32**. The first organic layer **33** is disposed on the underlay structure layer **32**, and the first hollow portion **321** is filled with the first organic layer **33**.

The active layer **34** is disposed on the first organic layer **33**. The first insulating layer **35** is disposed on the active layer **34**. A second hollow portion **351** is disposed in the first insulating layer **35** and arranged corresponding to the first hollow portion **321**. The first organic layer **33** is exposed from the second hollow portion **351**. The second organic layer **36** is disposed on the first insulating layer **35**, and the second hollow portion **351** is filled with the second organic layer **36**.

The first gate-electrode metal layer **37** is disposed on the second organic layer **36**, and the metal trace **371** is disposed above the second hollow portion **351** correspondingly.

The second insulating layer **38** is disposed on the first gate-electrode metal layer **37**. The second gate-electrode metal layer **39** is disposed on the second insulating layer **38**. The third insulating layer **310** is disposed on the second gate-electrode metal layer **39**. A third hollow portion **311** is disposed in the third insulating layer **310** and passes through the metal trace **371**. The second organic layer **36** is exposed from the third hollow portion **311**. The third organic layer **320** is disposed on the third insulating layer **310**, and the third hollow portion **311** is filled with the third organic layer **320**. The source-and-drain electrode metal layer **330** is disposed on the third organic layer **320**. The source-and-drain electrode metal layer **330** includes a passing bridge **331**. The split metal traces **371** are electrically connected together through the passing bridge **331**.

The first organism **301** is formed from the first organic layer **33** which fills the first hollow portion **321**, and the second organic layer **36** which fills the second hollow portion **351**. The second organism **302** is formed from the third organic layer **320** which fills the third hollow portion **311**.

The second organism **302** extends into the opening **372** to be in contact with the first organism **301**.

In the third embodiment, the source-and-drain electrode metal layer **330** includes the passing bridge **331**. The metal trace **371** includes a first section **3711** and a second section **3712**. The opening **372** disconnects the first section **3711** from the second section **3712**.

The first section **3711** is electrically connected to one end of the passing bridge **331** through a through-hole, and the second section **3712** is electrically connected to the other end of the passing bridge **331** through another through-hole.

The difference that exists between the third embodiment and the first embodiment is that the structures of the metal trace **371** and the second organism **302** are different. Specifically, other structures can be referred in the description of the first embodiment.

Compared with a display panel in conventional technologies, in the display panel of the present disclosure, organic materials are disposed above a metal trace and below the metal trace. Because of the flexibility of the organic materials, a stress which occurs in inorganic layers can be effectively released through the organic materials when the display panel is being bent, further preventing the metal trace from breaking. Thus, a technical problem that a gate-electrode metal layer and/or an active layer break while a conventional display panel is bent or folded can be solved.

A person of ordinary skill in the art is able to make modifications or changes corresponding to the foregoing description based on the technical solutions and the technical ideas of the present disclosure, and all of these modifications and changes should be within the protective scope of the appended claims of the present disclosure.

What is claimed is:

1. A display panel, comprising:

a substrate;

a first gate-electrode metal layer disposed on the substrate, wherein the first gate-electrode metal layer comprises a metal trace, the metal trace comprises a first surface and a second surface disposed opposite to each other, and the first surface is located on one side of the metal trace near the substrate;

a first organism disposed on one surface of the first gate-electrode metal layer near the substrate in order that a bending stress is released;

a second organism disposed on one surface of the first gate-electrode metal layer away from the substrate in order that the bending stress is released, wherein the first organism is disposed on one side of the first surface, the second organism is disposed on one side of the second surface, the first organism is in contact with the first surface, and the second organism is in contact with the second surface;

an underlay structure layer disposed on the substrate, wherein a first hollow portion is defined in the underlay structure layer;

a first organic layer disposed on the underlay structure layer, wherein the first hollow portion is filled with the first organic layer;

an active layer disposed on the first organic layer;

a first insulating layer disposed on the active layer, wherein a second hollow portion is defined in the first insulating layer and arranged corresponding to the first hollow portion, and the first organic layer is exposed from the second hollow portion;

a second organic layer disposed on the first insulating layer, wherein the second hollow portion is filled with the second organic layer, the first gate-electrode metal layer is disposed on the second organic layer, and the metal trace is disposed above the second hollow portion correspondingly;

a second insulating layer disposed on the first gate-electrode metal layer;

a second gate-electrode metal layer disposed on the second insulating layer;

a third insulating layer disposed on the second gate-electrode metal layer, wherein a third hollow portion is defined in the third insulating layer and extends through the second insulating layer, and the metal trace is exposed from the third hollow portion;

a third organic layer disposed on the third insulating layer, wherein the third hollow portion is filled with the third organic layer; and

a source-and-drain electrode metal layer disposed on the third organic layer;

wherein the first organism is formed from the first organic layer which fills the first hollow portion, and the second organic layer which fills the second hollow portion; and

wherein the second organism is formed from the third organic layer which fills the third hollow portion.

2. A display panel, comprising:

a substrate;

a first gate-electrode metal layer disposed on the substrate;

a first organism disposed on one surface of the first gate-electrode metal layer near the substrate in order that a bending stress is released; and

a second organism disposed on one surface of the first gate-electrode metal layer away from the substrate in order that the bending stress is released;

wherein the first gate-electrode metal layer comprises a metal trace, the metal trace comprises a first surface and a second surface disposed opposite to each other, and the first surface is located on one side of the metal trace near the substrate;

wherein the first organism is disposed on one side of the first surface, and the second organism is disposed on one side of the second surface; and

wherein a hole is defined in the metal trace, and the second organism extends through and fills the hole and contacts the first organism.

3. A display panel, comprising:

a substrate;

a first gate-electrode metal layer disposed on the substrate;

a first organism disposed on one surface of the first gate-electrode metal layer near the substrate in order that a bending stress is released; and

a second organism disposed on one surface of the first gate-electrode metal layer away from the substrate in order that the bending stress is released;

wherein the first gate-electrode metal layer comprises a metal trace, the metal trace comprises a first surface and a second surface disposed opposite to each other, and the first surface is located on one side of the metal trace near the substrate;

wherein the first organism is disposed on one side of the first surface, and the second organism is disposed on one side of the second surface; and

wherein an opening is defined in the metal trace, the opening splits the metal trace into two sections, and the second organism extends through and fills the opening and contacts the first organism.

4. The display panel of claim **2**, further comprising:

an underlay structure layer disposed on the substrate, wherein a first hollow portion is defined in the underlay structure layer;

a first organic layer disposed on the underlay structure layer, wherein the first hollow portion is filled with the first organic layer;

an active layer disposed on the first organic layer;

a first insulating layer disposed on the active layer, wherein a second hollow portion is defined in the first insulating layer and arranged corresponding to the first hollow portion, and the first organic layer is exposed from the second hollow portion;

a second organic layer disposed on the first insulating layer, wherein the second hollow portion is filled with the second organic layer, the first gate-electrode metal layer is disposed on the second organic layer, and the metal trace is disposed above the second hollow portion correspondingly;

a second insulating layer disposed on the first gate-electrode metal layer;

a second gate-electrode metal layer disposed on the second insulating layer;

a third insulating layer disposed on the second gate-electrode metal layer, wherein a third hollow portion is defined in the third insulating layer and passes through the metal trace, and the second organic layer is exposed from the second hollow portion;

a third organic layer disposed on the third insulating layer, wherein the third hollow portion is filled with the third organic layer; and

a source-and-drain electrode metal layer disposed on the third organic layer;

wherein the first organism is formed from the first organic layer which fills the first hollow portion, and the second organic layer which fills the second hollow portion; and

wherein the second organism is formed from the third organic layer which fills the third hollow portion.

5. The display panel of claim **3**, further comprising:

an underlay structure layer disposed on the substrate, wherein a first hollow portion is defined in the underlay structure layer;

a first organic layer disposed on the underlay structure layer, wherein the first hollow portion is filled with the first organic layer;

an active layer disposed on the first organic layer;

a first insulating layer disposed on the active layer, wherein a second hollow portion is defined in the first insulating layer and arranged corresponding to the first hollow portion, and the first organic layer is exposed from the second hollow portion;

a second organic layer disposed on the first insulating layer, wherein the second hollow portion is filled with the second organic layer, the first gate-electrode metal layer is disposed on the second organic layer, and the metal trace is disposed above the second hollow portion correspondingly;

a second insulating layer disposed on the first gate-electrode metal layer;

a second gate-electrode metal layer disposed on the second insulating layer;

a third insulating layer disposed on the second gate-electrode metal layer, wherein a third hollow portion is defined in the third insulating layer and passes through

and splits the metal trace, and the second organic layer is exposed from the third hollow portion;

a third organic layer disposed on the third insulating layer, wherein the third hollow portion is filled with the third organic layer; and

a source-and-drain electrode metal layer disposed on the third organic layer and comprising a passing bridge, wherein the split metal traces are electrically connected together through the passing bridge;

wherein the first organism is formed from the first organic layer which fills the first hollow portion, and the second organic layer which fills the second hollow portion; and

wherein the second organism is formed from the third organic layer which fills the third hollow portion.

6. The display panel of claim **1**, further comprising:

a third organism disposed on one surface of the active layer near the substrate; and

a fourth organism disposed on one surface of the active layer away from the substrate.

7. The display panel of claim **4**, further comprising:

a third organism disposed on one surface of the active layer near the substrate; and

a fourth organism disposed on one surface of the active layer away from the substrate.

8. The display panel of claim **5**, further comprising:

a third organism disposed on one surface of the active layer near the substrate; and

a fourth organism disposed on one surface of the active layer away from the substrate.

9. The display panel of claim **5**, wherein the source-and-drain electrode metal layer comprises the passing bridge, the metal trace comprises a first section and a second section, and the opening disconnects the first section from the second section; and

wherein the first section is electrically connected to one end of the passing bridge through a through-hole, and the second section is electrically connected to the other end of the passing bridge through another through-hole.

10. The display panel of claim **6**, wherein a fourth hollow portion is defined in the underlay structure layer, the fourth hollow portion is filled with the first organic layer, a part of the active layer is disposed above the fourth hollow portion correspondingly;

wherein a fifth hollow portion is defined in the first insulating layer and arranged corresponding to a part of the active layer, a part of the active layer is exposed from the fifth hollow portion, and the fifth hollow portion is filled with the second organic layer;

wherein a sixth hollow portion is defined in the third insulating layer and passes through the second insulating layer, the second organic layer is exposed from the sixth hollow portion, the sixth hollow portion is defined corresponding to the fifth hollow portion, and the sixth hollow portion is filled with the third organic layer;

wherein the third organism is formed from the first organic layer which fills the fourth hollow portion; and

wherein the fourth organism is formed from the second organic layer which fills the fifth hollow portion, and the third organic layer which fills the sixth hollow portion.

11. The display panel of claim **10**, further comprising a fifth organism disposed on one or two sides of the active layer and/or the metal trace.

12. The display panel of claim **10**, wherein the first hollow portion, the second hollow portion, the third hollow portion, the fourth hollow portion, the fifth hollow portion, and the sixth hollow portion have shapes of hole or groove.

13. The display panel of claim **7**, wherein a fourth hollow portion is defined in the underlay structure layer, the fourth hollow portion is filled with the first organic layer, a part of the active layer is disposed above the fourth hollow portion correspondingly;

wherein a fifth hollow portion is defined in the first insulating layer and arranged corresponding to a part of the active layer, a part of the active layer is exposed from the fifth hollow portion, and the fifth hollow portion is filled with the second organic layer;

wherein a sixth hollow portion is defined in the third insulating layer and passes through the second insulating layer, the second organic layer is exposed from the sixth hollow portion, the sixth hollow portion is arranged corresponding to the fifth hollow portion, and the sixth hollow portion is filled with the third organic layer;

wherein the third organism is formed from the first organic layer which fills the fourth hollow portion; and

wherein the fourth organism is formed from the second organic layer which fills the fifth hollow portion, and the third organic layer which fills the sixth hollow portion.

14. The display panel of claim **13**, further comprising a fifth organism disposed on one or two sides of the active layer and/or the metal trace.

15. The display panel of claim **8**, wherein a fourth hollow portion is defined in the underlay structure layer, the fourth hollow portion is filled with the first organic layer, a part of the active layer is disposed above the fourth hollow portion correspondingly;

wherein a fifth hollow portion is defined in the first insulating layer and arranged corresponding to a part of the active layer, a part of the active layer is exposed from the fifth hollow portion, and the fifth hollow portion is filled with the second organic layer;

wherein a sixth hollow portion is defined in the third insulating layer and passes through the second insulating layer, the second organic layer is exposed from the sixth hollow portion, the sixth hollow portion is disposed corresponding to the fifth hollow portion, and the sixth hollow portion is filled with the third organic layer;

wherein the third organism is formed from the first organic layer which fills the fourth hollow portion; and

wherein the fourth organism is formed from the second organic layer which fills the fifth hollow portion, and the third organic layer which fills the sixth hollow portion.

16. The display panel of claim **15**, further comprising a fifth organism disposed on one or two sides of the active layer and/or the metal trace.

17. The display panel of claim **15**, wherein the first hollow portion, the second hollow portion, the third hollow portion, the fourth hollow portion, the fifth hollow portion, and the sixth hollow portion have shapes of hole or groove.

* * * * *